Summed radiocarbon probability distributions from cereal grains: arable cultivation proxy or the 'archaeology of us'? (a reply to Stevens and Fuller 2015)

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Abstract
In response to the critique in this volume (Bishop 2015), Stevens and Fuller (2015) have modified their original interpretation of Late Neolithic subsistence strategies in the British Isles (Stevens and Fuller 2012). This paper highlights the key issues that remain with their analysis. It is reiterated that radiocarbon summed probability distributions from cereals are not a suitable proxy for the changing importance of arable cultivation through time.

Keywords
Neolithic, cereal cultivation, archaeobotany, radiocarbon summed probability, research bias

In response to the critique in this volume (Bishop 2015), Stevens and Fuller (2015) have modified their original interpretation of Late Neolithic subsistence strategies in the British Isles (Stevens and Fuller 2012). For instance, they have incorporated some additional data and they now accept that there is evidence for continued cultivation between 3300-2500 cal BC, with an abandonment of wheat (but not barley) in Late Neolithic Scotland (Bishop, Church, and Rowley-Conwy 2009; Bishop 2015). This reply will briefly highlight the key issues that remain with their analysis.

Data inclusion

As stated in Bishop (2015:9), the evidence for Late Neolithic cereal cultivation in the south of Scotland is insubstantial, but there is good evidence for cereal cultivation after 3300 cal BC on the Scottish islands (Bishop, Church, and Rowley-Conwy 2009), and elsewhere in mainland Scotland (see supplementary table 1). Further radiocarbon dating is necessary to resolve the chronology of the undated cereal assemblages.

Stevens and Fuller (2015) state that their "original dataset has been augmented by the four dates listed by Bishop, as well as 43 dates on cereals drawn from the radiocarbon database for Scotland." It is unclear which dates are referred to here because 17 direct Late Neolithic dates on cereals (from 5 sites) were included in Bishop (2015) that were not analysed by Stevens and Fuller (2012) (NB: 37, rather than 47 is the 'new' Scottish sample size shown in Stevens and Fuller 2015 figure 1). The Scottish Radiocarbon database (Ashmore 2009; completed in 2005 and updated with only Historic Scotland funded dates up to 2010), obtained from the RCAHMS in August 2015 by the present author, contained 211 direct cereal dates (from 57 sites) between c. 4000-700 cal BC, whereas Stevens and Fuller (2015, figure 1) included 170 Scottish dates in this period. The systematic compilation of a more complete dataset for the British Isles is necessary before unitary models can be tested.

Research and taphonomic bias

Stevens and Fuller (2015) now accept that, "relatively very high peaks in Neolithic dates compared to later Bronze Age (Fig. 1) might reflect some bias in data collection", but they propose that, "if dating is substantially biased towards any one period then a full cycle, from boom to bust and back to boom, would not appear." The fact that there are multiple 'boom-bust cycles' does not negate the possibility that some – or all – peaks and troughs could reflect research or taphonomic bias. For instance, in contrast to the methodology of Collard et al (2010:867) (see also Shennan 2013, Shennan et al 2013; Timpson et al 2014), Stevens and Fuller (2012) did not normalise their radiocarbon dataset to ensure that site phases with multiple dates are equivalent to site phases with single dates. Consequently increased sampling is responsible for the apparent Early Neolithic radiocarbon 'peak' (compare Bishop 2015 figures 1(b) to 1(c) and 2(b) to 2(c)).

Stevens and Fuller (2015) propose that the Early and Late Neolithic have received a comparable level of research attention because of the research significance of later Neolithic monuments and the continued presence of radiocarbon dated hazelnuts in the Late Neolithic. Whilst there has been a concerted effort to improve the dating of some later Neolithic monuments in the British Isles, this would have little impact on the number of radiocarbon dates from cereals: cereals are relatively infrequent in such contexts (cf. Bishop, Church, and Rowley-Conwy 2009) because monumental sites were not the primary location of crop processing and consumption, and because sampling has generally been less intensive at these sites. Taphonomic factors may also have reduced Late Neolithic site visibility: intensive agricultural practices in the 2nd millennium cal BC may have destroyed much later Neolithic evidence for settlement and cultivation (McCullagh 1998:29).

Moreover, the continued presence of hazelnut dates in the Late Neolithic is unrelated to the importance of cereals in the economy. The direct AMS radiocarbon dating of cereal grains was not an option when many of the assemblages were excavated and so other materials were dated (Bishop 2015). Likewise, in many instances, cereal grains are not the best option for dating due to their low mass or poor preservation (a common situation with Neolithic assemblages in the British Isles) or because other suitable materials are present in key contexts relating to the site chronology. In contrast, most nutshell or charcoal fragments (>2mm) are of sufficient mass for radiocarbon dating and they may be preferentially selected for dating.

Cereal radiocarbon dates as a population proxy

Stevens and Fuller (2015) contend that, "fewer people equal fewer settlements, fewer archaeobotanical assemblages and fewer radiocarbon dates" and argue that because other studies incorporating other dated materials have produced similar distributions (e.g. Collard et al. 2010; Shennan et al. 2013), "charred remains of edible plants represent not just plant use but are a reasonable proxy for human population."

Clearly, fewer radiocarbon dates does not necessarily mean fewer archaeobotanical assemblages, because many assemblages have been dated multiple times - or not at all - and some sites have been poorly sampled, reducing the chance of recovering material suitable for dating. It is also unsurprising that the summed cereal dates produce a similar distribution to the total summed dataset of Collard et al (2010), because the cereal dataset is essentially a subset of this larger dataset.

There are also key methodological differences between Collard et al (2010) and Stevens and Fuller (2012, 2015). Collard et al (2010) propose that the dates within their summed plots represent individual site phases, which when combined give an approximation of the relative amount of human activity through time. Assuming for a moment that there were no taphonomic or research biases (Shennan 2013:305), this should be a reasonable proxy because the dates were produced with the aim of dating the archaeological site phases represented. In contrast, radiocarbon dates from cereals do not represent all site phases where cereals were used because the primary aim is generally not to date the use of the cereals. Therefore, the combined number of cereal dates through time will not equate to the relative amount of cereal cultivation through time.

Stevens and Fuller (2015) also argue that hazelnuts are relatively more important compared to cereals in the Late Neolithic because summed probability levels fell more for cereals than hazelnuts. Considering the biases discussed above, it is clear that the relative numbers of hazelnut and cereal dates through time does not directly reflect the relative numbers of sites with cereals and hazelnuts. Many of the sites have evidence for the use of both cereals and hazelnuts (Bishop, Church, and Rowley-Conwy 2009), often only one of these remains has been radiocarbon dated. This issue also applies to wheat and barley radiocarbon dates (Stevens and Fuller 2015, figure 3): since only one taxon is frequently radiocarbon dated when both are present, the summed dates are incomparable.

Proposed date of the 'collapse' in arable agriculture

Stevens and Fuller (2015) are inconsistent about the date of their proposed arable decline: in some instances they suggest a date of c. 3600 cal BC (ibid:6), and in others c. 3400/3300 cal BC (ibid:1) or c. 3000/2900 cal BC (ibid:3, figure 2). They have also shifted the date of arable 'collapse' from 3350 cal BC (Stevens and Fuller 2012:718) to 2900 cal BC (Stevens and Fuller 2015, figure 1). Furthermore, they (ibid:3) propose that the existence of some cereal radiocarbon dates in the period 3000-2500 cal BC shows that, "either cultural subsistence practices prevented it [agriculture] from re-establishing or such cereal farmers were rare and short-lived." Alternatively, these dates contradict Stevens and Fuller's (2012) model, perhaps reflecting widespread continuity of cereal cultivation.

Conclusions

Detailed consideration of taphonomic and research biases suggests that summed radiocarbon probability distributions from cereals are not a suitable proxy for the changing importance of arable cultivation through time. Further sampling, analysis, dating and synthesis of Late Neolithic archaeobotanical remains is necessary to assess whether there was a significant and widespread arable decline in the Late Neolithic across the British Isles.

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Supplementary table 1: Sites on mainland Scotland with secure dating evidence for late Neolithic cultivation. Dates were recalibrated using IntCal13 (Reimer et al. 2013) within OxCal v 4.2.4 (Bronk Ramsey 2009).

Site	Stevens and Fuller's (2015) description of quantity cereal grains	Stevens and Fuller's (2015) Comments	Region	Rosie Bishop's Comments
Carsie Mains	76 cereal grains, undated. Barley and naked barley	The radiocarbon date is on hazelnut shell, 3350-2930 cal. BC, in line with other Middle Neolithic cereal and nut dates. (Fig. 2) (Brophy and Barclay 2004)	Perthshire, North-East Scotland	The late Neolithic radiocarbon date (3340-2918 cal BC: Bishop 2015 table 1) is on charcoal from the rectangular timber structure where the cereal grains were recovered (see Brophy and Barclay 2004). The deposit of 76 naked barley grains is from an undated fill of a feature forming the side walls of the structure (ibid). The hazelnut date comes from the timber circle rather than the timber setting (ibid).
Kinbeachie	n/a	n/a	Highland, North-East Scotland	451 Neolithic cereal grains (Holden and Hastie 2001). Individual radiocarbon dates for the site span the early-late Neolithic transition (Barclay et al 2001). 3 direct dates on barley grains: 3499-3101 cal BC, 3341-2941 cal BC, 3498-3098 cal BC.

Lairg	3546 grains in total (1158 barley 1980 naked barley 408 emmer wheat)	The secure deposit is within a truncated pit sealed by a cairn & buried soil. The date is on wood charcoal from the pit or buried soil under cairn. The date is in line with other directly dated cereals. But the context of the dated wood charcoal and grain appears uncertain. Compare comments on p.95 to those on p.98 (McCullagh and Tipping 1998). Within the text, Stevens and Fuller (2015) also propose that the cereal deposit at Lairg site 0870 is uncertain and that it could, "potentially be of an earlier date than the charcoal radiocarbon date, judging by the context descriptions (see Table 1; Holden 1998, 169; McCullagh and Tipping 1998, 95, 98)."	Highland, Northern Scotland	Page 98 of McCullagh and Tipping (1998) is referring to a different site altogether (another cairn: 'Clearance Cairn 1') rather than the cairn at site 0870. The pit containing the deposit of 3546 naked barley and emmer wheat grains and radiocarbon dated charcoal at site 0870 is sealed by a later cairn (ibid) and is a very secure context (Rod McCullagh pers. comm.). There is no suggestion in McCullagh and Tipping (1998) or Holden (1998) that the cereals could potentially be an earlier date. The confusion about the 'context' discussed on p169 of Holden (1998) refers to the fact that the wider evidence for the Neolithic settlement where the cereals may have originated (where they were stored and accidentally charred) is uncertain (Rod McCullagh pers. comm.; see also p166: "It is possible that the cairn that was identified as Site 0870…overlay one element of a more extensive Neolithic site"), rather than an uncertainty about the context number of the charcoal and grain, which is listed as context 7117 (a pit underlying a cairn with radiocarbon dated charcoal).
Stoneyhill Farm	825+ cereal grains mostly naked barley	Has two direct dates on a rich deposit of naked barley dating to 3370-3110 cal. BC and 3340-3100 cal. BC (Fig. 2). See Suddaby and Ballin (2010)	Aberdeenshire, North-East Scotland	2 direct dates (3369-3098 and 3349-3033 cal BC) on naked barley from pit F81 that contained 825 cereal grains (Suddaby and Ballin 2010).

Upper Forth Crossing	No quantity reported	Two radiocarbon dates securely middle Neolithic, 3490-3100 cal. BC and 3340-2930 cal. BC.	Fife, North-East Scotland	2 direct dates on naked barley grain: 3489-3104 and 3339-2933 cal BC (ScARF 2012).